Kamiesberg Municipality

KAMIESKROON OXIDATION POND SYSTEM

DESIGN REPORT

Revisions				
No	**Date**	**Compiled**	**Reviewed**	**Description**
00	2020-05-19	BVi Consulting Engineers	E Myburgh	Original draft for review

SUBMITTED BY:

BVi Consulting Engineers

19 May 2020

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REVIEWED BY CLIENT

(MARK APPROPRIATE BOX WITH AN "X")

	A	**REVIEWED AND ACCEPTED.**
	B	**REVIEWED AND ACCEPTED AS NOTED.** **WORK MAY PROCEED SUBJECT TO INCORPORATION OF CHANGES AS INDICATED. REVISE & RE-SUBMIT FOR REVIEW.**
	C	**REVISE AND RE-SUBMIT FOR REVIEW.** **WORK MAY NOT PROCEED.**
	D	**NO FURTHER REVIEW REQUIRED.**

CLIENT APPROVAL:

NAME: _____ **SIGNATURE:** _____ **DATE:** _____

NAME: _____ **SIGNATURE:** _____ **DATE:** _____

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1. INTRODUCTION

BVi Consulting Engineers was appointed by Kamiesberg Municipality as engineering project managers to evaluate the capacity of the existing oxidation pond system in Kamieskroon. In addition, an investigation was done to determine the current and existing demand on the oxidation pond system to determine what upgrades, if any, are necessary.

1.1 BACKGROUND

1.1.1 GENERAL

Kamieskroon is situated next to the N7 national road in the Northern Cape, about 65km from Springbok and 45km from Garies. It is a small rural village which falls under the low-income category and the people of Kamieskroon mostly depend on work on nearby commercial farms and to a lesser extent the mines in the Namakwa District.

Figure 1: Location of Kamieskroon in the Northern Cape

1.1.2 POPULATION

The most recent information with regards to the population is 1 670 according to the number of plots and assuming that there are approximately 4.5 people per household. Refer to Table 1 for the number of plots and residents in Kamieskroon. A population increase of 0.5% per annum is assumed, resulting in a future population of 1 845 in 2039.

Table 1: Number of plots and residents in Kamieskroon

Description of Items	Current 2019		Future 2039	
	Plots	**Residents**	**Plots**	**Residents**
Calculated number	371	1670	410	1845

2. EXISTING SERVICES

2.1 Sewer Supply Network

The sewer network of Kamieskroon consists of uPVC pipes with a total length of ± 3,4km. The network consists of two (2) gravitational networks that connect to the oxidation ponds. The one network connects directly to the oxidation ponds and the other connects to a sewer pump station from where the sewage is pumped to the oxidation ponds. The main sewer pump station is located to the North of the town near the entrance of the town from the N7 National Road.

2.2 Oxidation Ponds

Kamieskroon has an oxidation pond system located about 420 metres north of the nearest residential area, Kroonsig. The system consists of the following:

- Two (2) anaerobic ponds
- One (1) primary pond
- Three (3) secondary ponds

Refer to Annexure A for a layout of the existing oxidation pond system and to Table 2 for the capacity of the existing system.

After surveys have been completed at the ponds, the existing capacity of the ponds was calculated as follows, the total current capacity is calculated at 7 727 m^3 and is currently overflowing.:

Table 2 Existing Oxidation Pond System

Existing Oxidation Ponds					
	Type	Number	Total Volume (m^3)	Total area (m^2)	Total Area (ha)
1	Anaerobic Ponds	2	1077	556	0.05
2	Primary Ponds	1	2324	2045.26	0.21
3	Secondary Ponds	3	3604	3316.128	0.33
4	Tertiary Ponds				
5	Evaporation Ponds				
	Total		7724	6473	0.59

This oxidation pond system does not comply with the specifications of the Department of Water and Sanitation. The ponds do not have any lining installed, allowing the possible infiltration of sewage water into the water table.

3. EVALUATION OF OXIDATION POND SYSTEM

3.1 Anaerobic, Primary and Secondary Ponds

Using the current and future populations the required capacity for the oxidation pond system were calculated using the following assumptions:

Sewer flow calculations

- Persons per household – 4.5
- Sewage flow/household – 400 l/day
- Peak flow factor – 2.5
- Oxidation pond calculations
- Biological Oxygen Demand/ person – 50 g/capita/day
- Anaerobic pond BOD removal – 50%

The daily sewer inflow was calculated using the population data along with the parameters mentioned and are shown in Table 3.

Table 3: Projected Sewer Inflow

Year	Population	Residences	Projected Flow m^3/day		
			m^3/day	Average Flow(ℓ/s)	Peak Flow (ℓ/s)
2019	1 670	371	148	1.72	4.30
2029	1 755	390	156	1.81	4.51
2039	1 845	410	164	1.90	4.75

3.1.1 ANAEROBIC PONDS

According to the flow calculations the town of Kamieskroon requires two anaerobic ponds with a capacity of 985 m^3 each. This will enable the anaerobic ponds to be used in parallel and the ponds can be alternated to ensure that the sedimentation build up in the ponds are controlled and that the pond depths will not be decreased over the 20-year life span of the oxidation pond system. The existing ponds will be upgraded and lined, to provide the required capacity. The existing ponds are slightly larger than the required capacity, but to save costs. The ponds will be used as is, with minor upgrades required along with the lining installation.

3.1.2 PRIMARY AND SECONDARY PONDS

The primary and secondary ponds are similar in nature and the function of these ponds are to provide sufficient retention/maturation periods for the sewer inflow. According to the design calculations, the Primary and Secondary Ponds require a combined volume of 6 610 m^3. The existing primary and secondary ponds can only provide a combined volume of 5 928m^3 if they are used individually and are therefore not sufficient to accommodate the future population growth. If two of the secondary ponds were to be combined, it would provide sufficient capacity. Refer to Annexure B for the layout of the combined ponds.

3.1.3 EVAPORATION PONDS

Calculations were made taking into account the daily sewer inflow and the daily evaporation tempo, to determine the minimum evaporation area required to ensure that the ponds do not overflow within the 20-year design period. These calculations take into account the gradual increase of water levels that will eventually lead to the ponds overflowing. The evaporation tempo varies between 5 mm/ha/day in the winter to 10mm/ha/day during the summer months. The calculations are shown in Annexure C.

4. DESIGN AREAS AND VOLUMES

The total design volumes and areas for the anaerobic, primary and secondary ponds are shown in Table 3. According to the calculations, in Annexure C, the Evaporation Ponds would need to have minimum evaporation area of 12 200 m^2 with a minimum volume of 11 067 m^3, also shown in Table 4.

Table 4: Final Design Capacities of the Upgraded Oxidation Pond System

Design Volumes and Areas					
	Type	Number	Design Volume (m^3)	Design Area (m^2)	(ha)
1	Anaerobic Ponds	2	1112	572	0.05
2	Primary Ponds	1	2298	2541	0.25
3	Secondary Ponds	3	4312	3577	0.36
4	Evaporation Ponds	3	11195	12226.	1.22
	Total		18 918	18 916	1.9

* There are two anaerobic ponds, the ponds will be used in parallel

In an attempt to minimize costs, the designs were done to utilise as much of the existing ponds as possible with minimum upgrades and changes required. The existing and design volumes are compared in Table 5. You will note that the existing anaerobic ponds have sufficient capacity. The combination of two of the secondary ponds into one pond is required to provide sufficient capacity for the primary and secondary ponds. The existing system however did not have any evaporation ponds and new lined evaporation ponds will therefore be required for the upgraded oxidation pond system.

Table 5: Comparison of existing and final design capacities

	Type	Existing Volume (m^3)	Design Volume (m^3)	Existing Area (m^2)	Design Area (m^2)	Comment
1	Anaerobic Ponds*	1077	1112	556	572	Existing Sufficient
2	Primary Ponds	2 324	2298	2 045	2 541	Combined areas insufficient
3	Secondary Ponds	3 604	4312	3 316	3 577	
4	Evaporation Ponds		11195		12 226	No Existing Evaporation Ponds
	Total	7 005	18 918	5 918	18 916	
* Two anaerobic ponds used in parallel						

4.1 Final Design Sizes

The current system does not have any evaporation ponds. The design for the ponds, taking into account the upgrades to the existing system, shows that the area required to provide sufficient evaporation area for the ponds for the next 20 years, is 12 266 m^2.

Taking into account the available area for the oxidation pond system, the volumes and areas for the various ponds for the upgrade are shown in Table 6. Refer to Annexure B for the layout of the ponds.

Table 6: Design Volumes and Areas

		Volume (m^3)	Area (m^2)
Pond 1	Anaerobic	1112.8	572
Pond 2	Anaerobic	1112.8	572
Total Anaerobic Ponds		***2225.6***	***1144***
Pond 3	Primary	2298	2541
Total Primary Ponds		***2298***	***2541***
Pond 4	Secondary	1305	1486
Pond 5	Secondary	3007	2091
Total Secondary Ponds		***4312***	***3577***
Pond 6	Evaporation Ponds	2769	3036
Pond 7	Evaporation Ponds	2769	3036
Pond 8	Evaporation Ponds	2769	3036
Pond 9	Evaporation Ponds	2888	3158
Total Evaporation Ponds		***11195***	***12266***

5. PROPOSED WORK

The current oxidation ponds are located South of the Kamieskroon town. The existing ponds and surrounding areas have been surveyed and it has been found that the existing ponds can be expanded to accommodate the increase in sewage flow from town.

The following activities are proposed to upgrade the oxidation pond system:

- The existing oxidation ponds should be upgraded to meet the specifications of the Department of Water and Sanitation and be used as anaerobic, primary and secondary ponds. New in– and outlet structures should be constructed and the ponds must be lined with 2mm HDPE – Lining. The lining will ensure that the ponds are sealed off.

- The size of the existing anaerobic ponds is sufficient, minor upgrades are required along with the lining of the ponds.

- The size of the existing primary ponds is sufficient; however, the ponds need to be lined.

- Two of the secondary ponds must be combined to provide one larger pond to provide sufficient capacity. These ponds must also be lined.

- The construction of four new evaporation ponds connecting to the existing system with in-and outlet structures and lined with 2mm HDPE – linings and geomembranes will be required as part of the upgrade.

- The construction of security fences around the extension of the oxidation pond system and the evaporation ponds will be part of the work.

Standard detail for the design of oxidation pond systems are shown in Annexure D. Some of the design parameters to take into account are the following:

- 0.8 m freeboard
- 1:2.5 embankment slopes
- 2 mm HDPE lining

6. COST ESTIMATE

The cost estimations for the project includes the scope of works as given in section 5. The total estimated cost is estimated at R 20 572 046.05 as shown in Table 7 below.

Table 7: Total Estimated Cost

Item	Description	Amount
1	Preliminary and General Costs	R 1,183,236.00
2	Earthworks and Lining at Existing Ponds	R 2,506,450.00
3.	Security Fencing at Existing Ponds	R 34,530.00
4.	Construction of New Oxidation Ponds	R 8,727,750.00
5.	Pipe Trenches for Sewer Pipeline	R 111,350.00
6.	Construction of Sewer Pipeline	R 52,300.00
7.	Security Fencing at New Oxidation Ponds	R 399,980.00
	Sub Total	R 13,015,596.00
8.	Plus 10% Contingencies	R 1,301,559.60
	Sub Total	R 14,317,155.60
9.	Plus 10% Contract Price Adjustments and Increases	R 1,431,715.56
	Sub Total	R 15,748,871.16
10.	Environmental Impact Assessment	R 250,000.00
11.	Engineering Expenses	R 1,889,864.54
	Sub Total	R 17,888,735.70
12.	Plus 15% VAT	R 2,683,310.35
	Total Estimated Expenses	**R 20,572,046.05**
	Number of Residents	1,590.00
	Unit Cost per Consumer (excluding VAT)	R 11,250.78

7. CONCLUSION

The capacity of the existing oxidation pond system is insufficient. The existing ponds also does not comply with the Department of Water and Sanitation guidelines. The upgrade and extension of the existing oxidation pond system, consisting of the upgrade and lining of existing ponds as well as the construction of evaporation ponds are recommended.

For any questions, contact this office, Tel: 027 7129990

Thank you

Annexure A :

Drawing: Existing Oxidation Pond System

DRAWING NOT PRINTED TO SCALE REDUCED FROM A1 TO A3.

DATE	21 Apr 2020
DRAWING SIZE	A1
REVISION	A

X	PRELIMINARY
	INFO ONLY
	FOR TENDER
	FOR CONSTRUCTION
	AS-BUILT

APPROVED BY COUNCIL / CLIENT

CITY ENGINEER / CLIENT | REG. NO. | DATE

DATE	INITIAL	No./CODE	REVISION DESCRIPTION
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CLIENT

PROJECT

KAMIESKROON
OXIDATION PONDS

DRAWING TITLE

GENERAL LAYOUT:

APPROVED BY IM

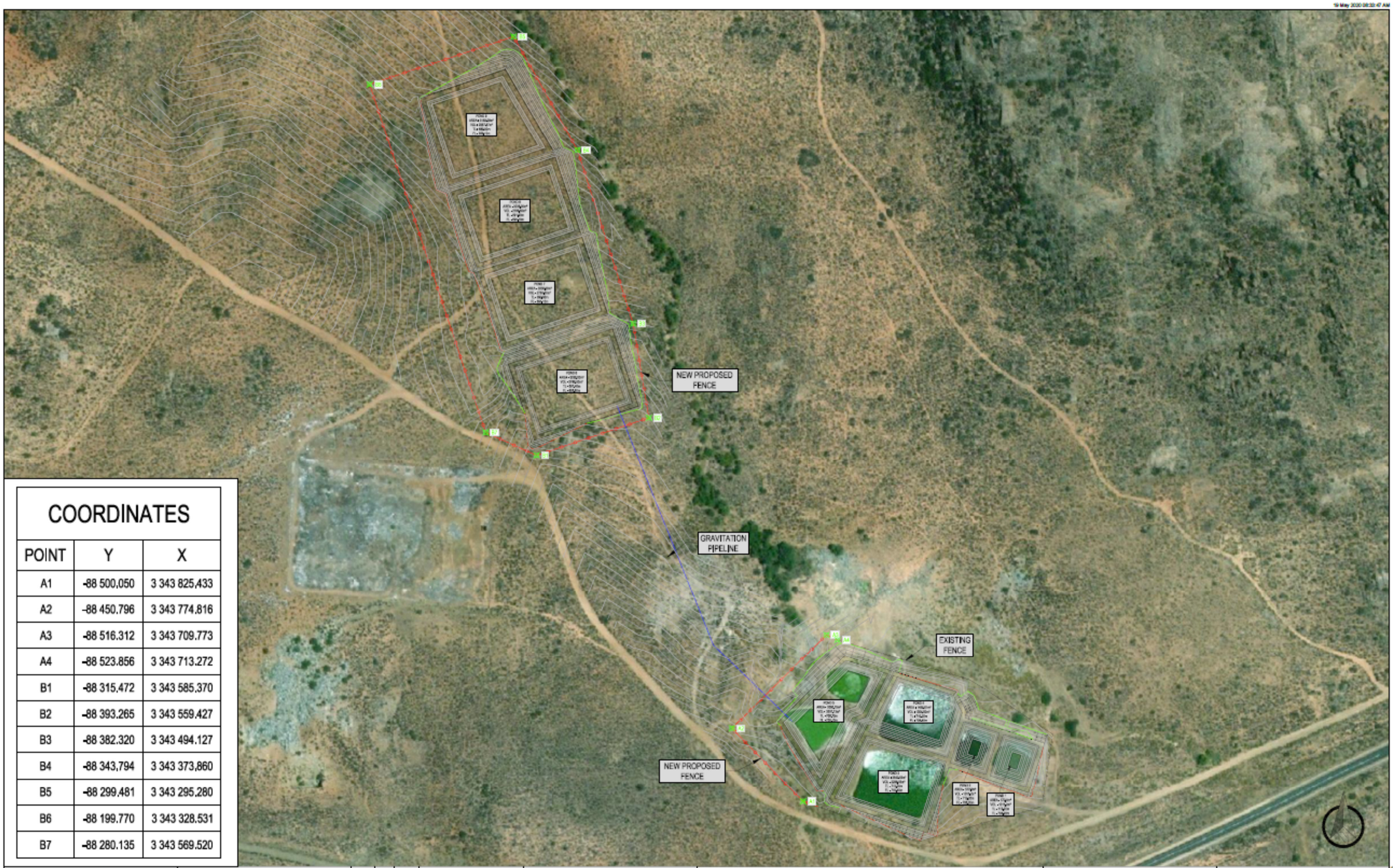
ENGINEER/TECHNOLOGIST | REG. NO. | DATE

SCALE	1:500	DRAWN	S.CLOETE
DESIGNED	W.CLOETE	CHECKED	W.CLOETE

PLAN NUMBER	REVISION NO.	DATE SAVED
31212.01S-100-01	A	21/04/2020

Annexure B:

Drawing: Layout of Upgraded Oxidation Pond System



COORDINATES

POINT	Y	X
A1	-88 500,050	3 343 825,433
A2	-88 450.796	3 343 774,816
A3	-88 516.312	3 343 709.773
A4	-88 523.856	3 343 713.272
B1	-88 315,472	3 343 585,370
B2	-88 393.265	3 343 559,427
B3	-88 382.320	3 343 494.127
B4	-88 343,794	3 343 373,860
B5	-88 299,481	3 343 295,280
B6	-88 199.770	3 343 328.531
B7	-88 280.135	3 343 569.520

NOTE / LEGENDS

DRAWING NOT PRINTED TO SCALE REDUCED FROM A1 TO A3

ISSUE DATE: 19 May 2020 | DRAWING SIZE: A1 | REVISION: B

X	PRELIMINARY
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(D - BY BM
(E - BY OTHER( )

DATE	INITIAL	No./CODE	REVISION DESCRIPTION
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CLIENT

KAMIESBERG MUNICIPALITY
"gems galore from mountains to shore"

bvi
Springbok Office

PROJECT

KAMIESKROON
OXIDATION PONDS

DRAWING TITLE

GENERAL LAYOUT

APPROVED BY BM

ENGINEER/TECHNOLOGIST | REG. NO. | DATE

SCALE	N/A	DRAWN	S.CLOETE
DESIGNED	S.CLOETE	CHECKED	W. CLOETE

PLAN NUMBER: 31212.02S-100-01 | REVISION NO.: B | DATE ISSUED: 19/05/2020

Annexure C: Evaporation Pond Calculations

Total Area for Oxidation Ponds System

	Anearobic Primary and Secondary ponds	Evaporation Ponds	TOTAL	
Area	7262.00	12266	19528.00	m2
Volume	8835.6	11195	20030.60	m3

	January	feb	March	April	May	June	July	August	September	October	November	December
Volume sewer inflow	4601.8	644.3	685.5	2080.4	979.2	740.8	667.9	636.4	790.6	953.7	783.8	1138.3
Average Evaporation Tempo (m)	0.310	0.280	0.310	0.210	0.217	0.150	0.155	0.155	0.210	0.310	0.300	0.310
Evaporation (m3) (evap temp x total pond area)	6053.7	5467.8	6053.7	4100.9	4237.6	2929.2	3026.8	3026.8	4100.9	6053.7	5858.4	6053.7

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Volume inflow	2019	4601.8	4156.4	4601.8	4453.3	4601.8	4453.3	4601.8	4601.8	4453.3	4601.8	4453.3	4601.8
Average Evaporation Tempo (m/month)		0.310	0.280	0.310	0.210	0.217	0.150	0.155	0.155	0.210	0.310	0.300	0.310
Evaporation (m3) (evap temp x area)		6053.7	5467.8	6053.7	4100.9	4237.6	2929.2	3026.8	3026.8	4100.9	6053.7	5858.4	6053.7
Volume available of water in Ponds		-1451.9	-1311.4	-1451.9	352.5	364.2	1524.1	1574.9	1574.9	352.5	-1451.9	-1405.1	-1451.9
Volume of water in ponds		0.0	0.0	0.0	352.5	716.7	2240.8	3815.7	5390.7	5743.1	4291.2	2886.1	1434.2
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Volume inflow	2020	4624.8	4177.2	4624.8	4475.6	4624.8	4475.6	4624.8	4624.8	4475.6	4624.8	4475.6	4624.8
Average Evaporation Tempo (m/month)		0.310	0.280	0.310	0.210	0.217	0.150	0.155	0.155	0.210	0.310	0.300	0.310
Evaporation (m3) (evap temp x area)		6053.7	5467.8	6053.7	4100.9	4237.6	2929.2	3026.8	3026.8	4100.9	6053.7	5858.4	6053.7
Volume available of water in Ponds		-1428.9	-1290.6	-1428.9	374.7	387.2	1546.4	1597.9	1597.9	374.7	-1428.9	-1382.8	-1428.9
Volume of water in ponds		5.4	0.0	0.0	374.7	761.9	2308.3	3906.3	5504.2	5878.9	4450.1	3067.3	1638.4
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Volume inflow	2021	4647.9106	4198.1128	4647.9106	4497.978	4647.9106	4497.978	4647.9106	4647.9106	4497.978	4647.9106	4497.978	4647.9106
Average Evaporation Tempo (m/month)		0.31	0.28	0.31	0.21	0.217	0.15	0.155	0.155	0.21	0.31	0.3	0.3102804
Evaporation (m3) (evap temp x area)		6053.68	5467.84	6053.68	4100.88	4237.576	2929.2	3026.84	3026.84	4100.88	6053.68	5858.4	6053.68
Volume available of water in Ponds		-1405.7694	-1269.7272	-1405.7694	397.098	410.3346	1568.778	1621.0706	1621.0706	397.098	-1405.769	-1360.422	-1405.769
Volume of water in ponds		232.5879333	0	0	397.098	807.4326	2376.2106	3997.2812	5618.3518	6015.4498	4609.6804	3249.2584	1843.489
Volume inflow		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Evaporation Tempo (m/month)	2022	4671.150153	4219.103364	4671.150153	4520.4679	4671.15015	4520.4679	4671.1502	4671.1502	4520.4679	4671.1502	4520.4679	4671.1502
Evaporation (m3) (evap temp x area)		0.31	0.28	0.31	0.21	0.217	0.15	0.155	0.155	0.21	0.31	0.3	0.3102804
Volume available of water in Ponds		6053.68	5467.84	6053.68	4100.88	4237.576	2929.2	3026.84	3026.84	4100.88	6053.68	5858.4	6053.68
Volume of water in ponds		-1382.529847	-1248.736636	-1382.52985	419.58789	433.574153	1591.2679	1644.3102	1644.3102	419.58789	-1382.53	-1337.932	-1382.53
		460.959153	0	0	419.58789	853.162043	2444.4299	4088.7401	5733.0502	6152.6381	4770.1083	3432.1762	2049.6463
Volume inflow		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Evaporation Tempo (m/month)	2023	4694.505904	4240.198881	4694.505904	4543.0702	4694.5059	4543.0702	4694.5059	4694.5059	4543.0702	4694.5059	4543.0702	4694.5059
Evaporation (m3) (evap temp x area)		0.31	0.28	0.31	0.21	0.217	0.15	0.155	0.155	0.21	0.31	0.3	0.3102804
Volume available of water in Ponds		6053.68	5467.84	6053.68	4100.88	4237.576	2929.2	3026.84	3026.84	4100.88	6053.68	5858.4	6053.68
Volume of water in ponds		-1359.174096	-1227.641119	-1359.1741	442.19023	456.929904	1613.8702	1667.6659	1667.6659	442.19023	-1359.174	-1315.33	-1359.174
		690.4722288	0	0	442.19023	899.120133	2512.9904	4180.6563	5848.3222	6290.5124	4931.3383	3616.0085	2256.8344
Volume inflow		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Evaporation Tempo (m/month)	2024	4717.978433	4261.399875	4717.978433	4565.7856	4717.97843	4565.7856	4717.9784	4717.9784	4565.7856	4717.9784	4565.7856	4717.9784
Evaporation (m3) (evap temp x area)		0.31	0.28	0.31	0.21	0.217	0.15	0.155	0.155	0.21	0.31	0.3	0.3102804
Volume available of water in Ponds		6053.68	5467.84	6053.68	4100.88	4237.576	2929.2	3026.84	3026.84	4100.88	6053.68	5858.4	6053.68
Volume of water in ponds		-1335.701567	-1206.440125	-1335.70157	464.90558	480.402433	1636.5856	1691.1384	1691.1384	464.90558	-1335.702	-1292.614	-1335.702
		921.1328699	0	0	464.90558	945.308014	2581.8936	4273.032	5964.1705	6429.076	5093.3745	3800.7601	2465.0585
Volume inflow		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Evaporation Tempo (m/month)	2025	4741.568325	4282.706875	4741.568325	4588.6145	4741.56833	4588.6145	4741.5683	4741.5683	4588.6145	4741.5683	4588.6145	4741.5683
Evaporation (m3) (evap temp x area)		0.31	0.28	0.31	0.21	0.217	0.15	0.155	0.155	0.21	0.31	0.3	0.3102804
Volume available of water in Ponds		6053.68	5467.84	6053.68	4100.88	4237.576	2929.2	3026.84	3026.84	4100.88	6053.68	5858.4	6053.68
Volume of water in ponds		-1312.111675	-1185.133125	-1312.11167	487.73451	503.992325	1659.4145	1714.7283	1714.7283	487.73451	-1312.112	-1269.785	-1312.112
		1152.946814	0	0	487.73451	991.726834	2651.1413	4365.8697	6080.598	6568.3325	5256.2208	3986.4353	2674.3237
Volume inflow		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Evaporation Tempo (m/month)	2026	4765.276167	4304.120409	4765.276167	4611.5576	4765.27617	4611.5576	4765.2762	4765.2762	4611.5576	4765.2762	4611.5576	4765.2762
Evaporation (m3) (evap temp x area)		0.31	0.28	0.31	0.21	0.217	0.15	0.155	0.155	0.21	0.31	0.3	0.3102804
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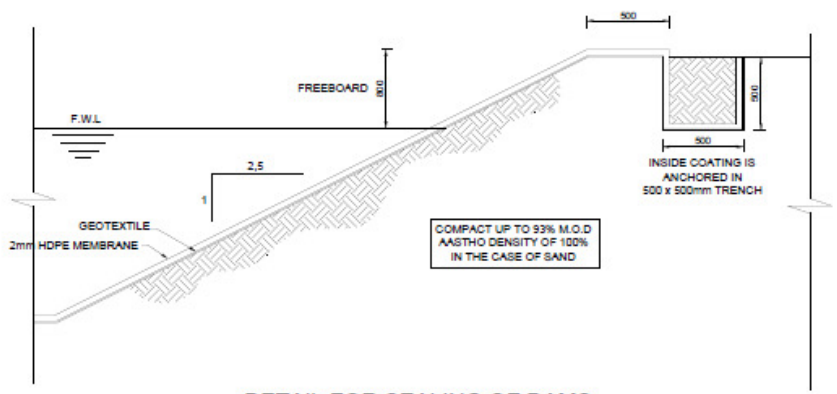
Volume of water in ponds		-1288.403833	-1163.719591	-1288.40383	510.67758	527.700167	1682.3576	1738.4362	1738.4362	510.67758	-1288.404	-1246.842	-1288.404
		1385.919828	222.2002373	0	510.67758	1038.37775	2720.7353	4459.1715	6197.6077	6708.2852	5419.8814	4173.039	2884.6352
Volume inflow		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Evaporation Tempo (m/month)	2027	4789.102548	4325.641011	4789.102548	4634.6154	4789.10255	4634.6154	4789.1025	4789.1025	4634.6154	4789.1025	4634.6154	4789.1025
Evaporation (m3) (evap temp x area)		0.31	0.28	0.31	0.21	0.217	0.15	0.155	0.155	0.21	0.31	0.3	0.3102804
Volume available of water in Ponds		6053.68	5467.84	6053.68	4100.88	4237.576	2929.2	3026.84	3026.84	4100.88	6053.68	5858.4	6053.68
Volume of water in ponds		-1264.577452	-1142.198989	-1264.57745	533.73537	551.526548	1705.4154	1762.2625	1762.2625	533.73537	-1264.577	-1223.785	-1264.577
		1620.057707	477.8587185	0	533.73537	1085.26192	2790.6773	4552.9398	6315.2024	6848.9378	5584.3603	4360.5757	3095.9982
Volume inflow		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Evaporation Tempo (m/month)	2028	4813.048061	4347.269216	4813.048061	4657.7884	4813.04806	4657.7884	4813.0481	4813.0481	4657.7884	4813.0481	4657.7884	4813.0481
Evaporation (m3) (evap temp x area)		0.31	0.28	0.31	0.21	0.217	0.15	0.155	0.155	0.21	0.31	0.3	0.3102804
Volume available of water in Ponds		6053.68	5467.84	6053.68	4100.88	4237.576	2929.2	3026.84	3026.84	4100.88	6053.68	5858.4	6053.68

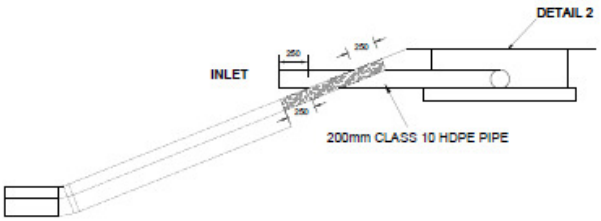
Volume of water in ponds		-1240.631939	-1120.570784	-1240.63194	556.90845	575.472061	1728.5884	1786.2081	1786.2081	556.90845	-1240.632	-1200.612	-1240.632
		1855.366276	734.7954921	0	556.90845	1132.38051	2860.969	4647.177	6433.3851	6990.2935	5749.6616	4549.05	3308.4181
Volume inflow	2029	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Evaporation Tempo (m/month)		4837.113301	4369.005562	4837.113301	4681.0774	4837.1133	4681.0774	4837.1133	4837.1133	4681.0774	4837.1133	4681.0774	4837.1133
Evaporation (m3) (evap temp x area)		0.31	0.28	0.31	0.21	0.217	0.15	0.155	0.155	0.21	0.31	0.3	0.3102804
Volume available of water in Ponds		6053.68	5467.84	6053.68	4100.88	4237.576	2929.2	3026.84	3026.84	4100.88	6053.68	5858.4	6053.68
Volume of water in ponds		-1216.566699	-1098.834438	-1216.5667	580.19739	599.537301	1751.8774	1810.2733	1810.2733	580.19739	-1216.567	-1177.323	-1216.567
		2091.851387	993.0169495	0	580.19739	1179.73469	2931.6121	4741.8854	6552.1587	7132.3561	5915.7894	4738.4668	3521.9001
Volume inflow	2030	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Evaporation Tempo (m/month)		4861.298867	4390.85059	4861.298867	4704.4828	4861.29887	4704.4828	4861.2989	4861.2989	4704.4828	4861.2989	4704.4828	4861.2989
Evaporation (m3) (evap temp x area)		0.31	0.28	0.31	0.21	0.217	0.15	0.155	0.155	0.21	0.31	0.3	0.3102804
Volume available of water in Ponds		6053.68	5467.84	6053.68	4100.88	4237.576	2929.2	3026.84	3026.84	4100.88	6053.68	5858.4	6053.68
Volume of water in ponds		-1192.381133	-1076.98941	-1192.38113	603.60277	623.722867	1775.2828	1834.4589	1834.4589	603.60277	-1192.381	-1153.917	-1192.381
		2329.518924	1252.529514	60.14838175	663.75116	1287.47402	3062.7568	4897.2157	6731.6745	7335.2773	6142.8962	4988.979	3796.5978
Volume inflow	2031	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Evaporation Tempo (m/month)		4885.605362	4412.804843	4885.605362	4728.0052	4885.60536	4728.0052	4885.6054	4885.6054	4728.0052	4885.6054	4728.0052	4885.6054
Evaporation (m3) (evap temp x area)		0.31	0.28	0.31	0.21	0.217	0.15	0.155	0.155	0.21	0.31	0.3	0.3102804
Volume available of water in Ponds		6053.68	5467.84	6053.68	4100.88	4237.576	2929.2	3026.84	3026.84	4100.88	6053.68	5858.4	6053.68
Volume of water in ponds		-1168.074638	-1055.035157	-1168.07464	627.12519	648.029362	1798.8052	1858.7654	1858.7654	627.12519	-1168.075	-1130.395	-1168.075
		2628.523181	1573.488024	405.4133854	1032.5386	1680.56794	3479.3731	5338.1385	7196.9038	7824.029	6655.9544	5525.5596	4357.4849
Volume inflow	2032	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Evaporation Tempo (m/month)		4910.033389	4434.868867	4910.033389	4751.6452	4910.03339	4751.6452	4910.0334	4910.0334	4751.6452	4910.0334	4751.6452	4910.0334
Evaporation (m3) (evap temp x area)		0.31	0.28	0.31	0.21	0.217	0.15	0.155	0.155	0.21	0.31	0.3	0.3102804
Volume available of water in Ponds		6053.68	5467.84	6053.68	4100.88	4237.576	2929.2	3026.84	3026.84	4100.88	6053.68	5858.4	6053.68
Volume of water in ponds		-1143.646611	-1032.971133	-1143.64661	650.76521	672.457389	1822.4452	1883.1934	1883.1934	650.76521	-1143.647	-1106.755	-1143.647
		3213.838338	2180.867205	1037.220594	1687.9858	2360.4432	4182.8884	6066.0818	7949.2752	8600.0404	7456.3938	6349.639	5205.9924
Volume inflow	2033	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Evaporation Tempo (m/month)		4934.583556	4457.043211	4934.583556	4775.4034	4934.58356	4775.4034	4934.5836	4934.5836	4775.4034	4934.5836	4775.4034	4934.5836
Evaporation (m3) (evap temp x area)		0.31	0.28	0.31	0.21	0.217	0.15	0.155	0.155	0.21	0.31	0.3	0.3102804
Volume available of water in Ponds		6053.68	5467.84	6053.68	4100.88	4237.576	2929.2	3026.84	3026.84	4100.88	6053.68	5858.4	6053.68
Volume of water in ponds		-1119.096444	-1010.796789	-1119.09644	674.52344	697.007556	1846.2034	1907.7436	1907.7436	674.52344	-1119.096	-1082.997	-1119.096
		4086.895952	3076.099163	1957.002719	2631.5262	3328.53372	5174.7372	7082.4807	8990.2243	9664.7477	8545.6513	7462.6547	6343.5583
Volume inflow	2034	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Evaporation Tempo (m/month)		4959.256473	4479.328428	4959.256473	4799.2805	4959.25647	4799.2805	4959.2565	4959.2565	4799.2805	4959.2565	4799.2805	4959.2565
Evaporation (m3) (evap temp x area)		0.31	0.28	0.31	0.21	0.217	0.15	0.155	0.155	0.21	0.31	0.3	0.3102804
Volume available of water in Ponds		6053.68	5467.84	6053.68	4100.88	4237.576	2929.2	3026.84	3026.84	4100.88	6053.68	5858.4	6053.68
Volume of water in ponds		-1094.423527	-988.5115725	-1094.42353	698.40046	721.680473	1870.0805	1932.4165	1932.4165	698.40046	-1094.424	-1059.12	-1094.424
		5249.134733	4260.623161	3166.199634	3864.6001	4586.28057	6456.361	8388.7775	10321.194	11019.594	9925.1709	8866.0514	7771.6278
Volume inflow	2035	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Evaporation Tempo (m/month)		4984.052756	4501.72507	4984.052756	4823.2769	4984.05276	4823.2769	4984.0528	4984.0528	4823.2769	4984.0528	4823.2769	4984.0528
Evaporation (m3) (evap temp x area)		0.31	0.28	0.31	0.21	0.217	0.15	0.155	0.155	0.21	0.31	0.3	0.3102804
Volume available of water in Ponds		6053.68	5467.84	6053.68	4100.88	4237.576	2929.2	3026.84	3026.84	4100.88	6053.68	5858.4	6053.68
Volume of water in ponds		-1069.627244	-966.1149303	-1069.62724	722.39686	746.476756	1894.0769	1957.2128	1957.2128	722.39686	-1069.627	-1035.123	-1069.627
		6702.000589	5735.885658	4666.258414	5388.6553	6135.13203	8029.2089	9986.4216	11943.634	12666.031	11596.404	10561.281	9491.6536
Volume inflow	2036	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Evaporation Tempo (m/month)		5008.973019	4524.233695	5008.973019	4847.3932	5008.97302	4847.3932	5008.973	5008.973	4847.3932	5008.973	4847.3932	5008.973
Evaporation (m3) (evap temp x area)		0.31	0.28	0.31	0.21	0.217	0.15	0.155	0.155	0.21	0.31	0.3	0.3102804
Volume available of water in Ponds		6053.68	5467.84	6053.68	4100.88	4237.576	2929.2	3026.84	3026.84	4100.88	6053.68	5858.4	6053.68
Volume of water in ponds		-1044.706981	-943.606305	-1044.70698	746.51324	771.397019	1918.1932	1982.133	1982.133	746.51324	-1044.707	-1011.007	-1044.707
		8446.946653	7503.340348	6458.633368	7205.1466	7976.54363	9894.7369	11876.87	13859.003	14605.516	13560.809	12549.802	11505.095
Volume inflow	2037	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Evaporation Tempo (m/month)		5034.017885	4546.854863	5034.017885	4871.6302	5034.01788	4871.6302	5034.0179	5034.0179	4871.6302	5034.0179	4871.6302	5034.0179
Evaporation (m3) (evap temp x area)		0.31	0.28	0.31	0.21	0.217	0.15	0.155	0.155	0.21	0.31	0.3	0.3102804
Volume available of water in Ponds		6053.68	5467.84	6053.68	4100.88	4237.576	2929.2	3026.84	3026.84	4100.88	6053.68	5858.4	6053.68
Volume of water in ponds		-1019.662115	-920.9851365	-1019.66212	770.75021	796.441885	1942.4302	2007.1779	2007.1779	770.75021	-1019.662	-986.7698	-1019.662
		10485.43333	9564.448192	8544.786076	9315.5363	10111.9782	12054.408	14061.586	16068.764	16839.514	15819.852	14833.082	13813.42
Volume inflow	2038	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Evaporation Tempo (m/month)		5059.187974	4569.589138	5059.187974	4895.9884	5059.18797	4895.9884	5059.188	5059.188	4895.9884	5059.188	4895.9884	5059.188
Evaporation (m3) (evap temp x area)		0.31	0.28	0.31	0.21	0.217	0.15	0.155	0.155	0.21	0.31	0.3	0.3102804
Volume available of water in Ponds		6053.68	5467.84	6053.68	4100.88	4237.576	2929.2	3026.84	3026.84	4100.88	6053.68	5858.4	6053.68
Volume of water in ponds		-994.492026	-898.2508622	-994.492026	795.10836	821.611974	1966.7884	2032.348	2032.348	795.10836	-994.492	-962.4116	-994.492
		12818.92832	11920.67745	10926.18543	11721.294	12542.9058	14509.694	16542.042	18574.39	19369.498	18375.006	17412.595	16418.103
Volume inflow	2039	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Evaporation Tempo (m/month)		5084.483914	4592.437083	5084.483914	4920.4683	5084.48391	4920.4683	5084.4839	5084.4839	4920.4683	5084.4839	4920.4683	5084.4839
Evaporation (m3) (evap temp x area)		0.243154073	0.243161361	0.243168649	0.2431759	0.24318323	0.2431905	0.2431978	0.2432051	0.2432124	0.2432197	0.243227	0.2432342
Volume available of water in Ponds		6053.68	5467.84	6053.68	4100.88	4237.576	2929.2	3026.84	3026.84	4100.88	6053.68	5858.4	6053.68
Volume of water in ponds		-969.1960861	-875.4029165	-969.196086	819.5883	846.907914	1991.2683	2057.6439	2057.6439	819.5883	-969.1961	-937.9317	-969.1961
		15448.90666	14573.50374	13604.30766	14423.896	15270.8039	17262.072	19319.716	21377.36	22196.948	21227.752	20289.821	19320.624

Annexure D

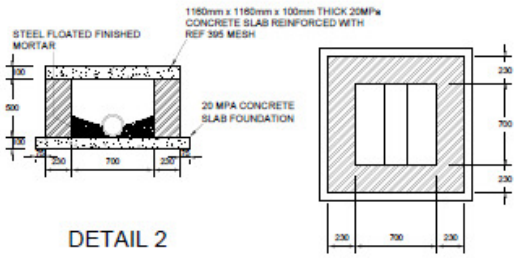
Drawings: Standard Detail for Oxidation Ponds



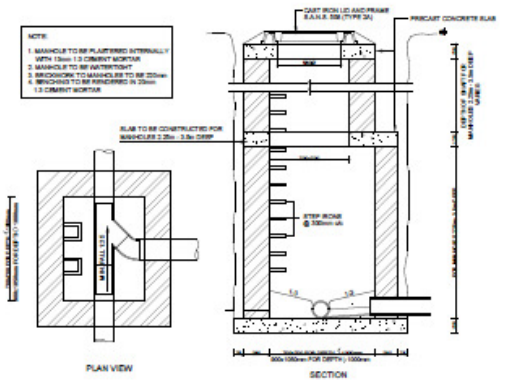
DETAIL FOR SEALING OF DAMS



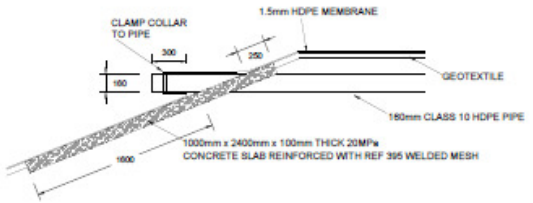
INLET STRUCTURE



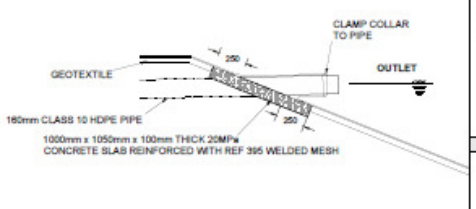
DETAIL 2



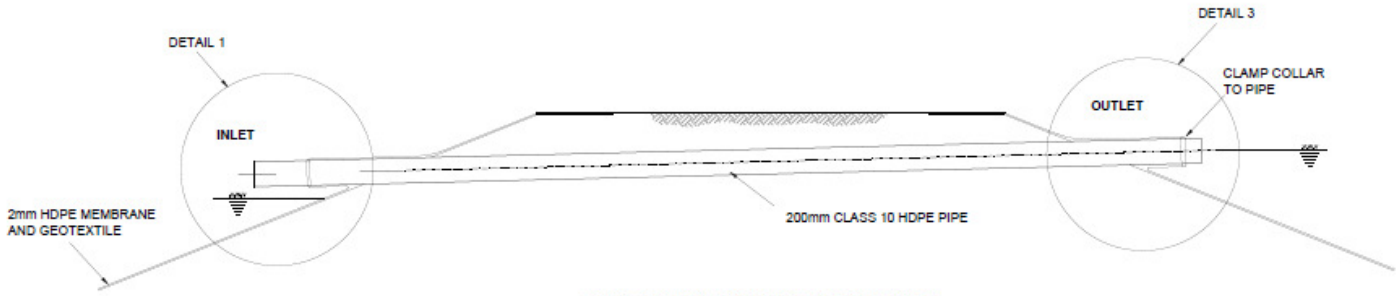
TYPICAL BRICK MANHOLE



DETAIL 1



DETAIL 3



OVERFLOW OUTLET STRUCTURE

NOTES / LEGEND

ISSUE DATE	DRAWING SIZE	REVISION
30 Apr 2020	A3	A

X	PRELIMINARY
	INFO ONLY
	FOR TENDER
	FOR CONSTRUCTION
	AS-BUILT

APPROVED BY COUNCIL / CLIENT

CITY ENGINEER / CLIENT | REG. NO. | DATE

AMENDMENTS CODE

A,B,C.../ : BEFORE TENDER
10 / : TENDER DRAWING
0,1,2.../ : AFTER TENDER
Z / : AS-BUILT

(A : BY CLIENT
(B : BY ARCHITECT
(C : BY MECHANICAL OR ELECTRICAL
(D : BY BM
(E : BY OTHER ( )

DATE	INITIAL	No./CODE	REVISION DESCRIPTION
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GENERAL SEWER DETAILS

APPROVED BY BVI

ENGINEER/TECHNOLOGIST	20192772 REG. NO.	OCT 2019 DATE

SCALE	N.T.S	DRAWN	R. ENGELBRECHT
DESIGNED	-	CHECKED	W. CLOETE

PLAN NUMBER	REVISION NO.	DATE ISSUED
31212.02S-133-01	A	30/04/2020

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